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XXXVI. *Experiments on Animal Fluids in the exhausted Receiver.* By D. Darwin, M. D. of Litchfield. Communicated by Dr. Franklin.

Redde, March 24. 1774. **T**HE antient opinion, that air exists in some of the blood-vessels, was exploded by the discovery of the circulation. But many of our modern theorists seem to have conceived, that an elastic vapour of some kind exists in the blood-vessels, as they have ascribed the lunar and equinoctial diseases to the variations of atmospheric pressure.

This opinion seems to have arisen from observing, that the skin rises, and that the vessels are distended, even to bursting, under a cupping-glass; when the pressure of the atmosphere is taken off from one part, and continues to act on all the remaining surface of the body: and would indeed, at first sight, appear to be demonstrated by the following experiments.

About four ounces of blood were taken from the arm of one of the attendants, and immediately put under the
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the receiver of an air-pump; and, as the air was exhausting, the blood began to swell, and to rise in bubbles, till it occupied above ten times its original space.

As false reasoning is, in no science, of more dangerous consequence, than in that of medicine, I persuaded myself the removal of this error might be thought worthy the attention of the Royal Society.

In April 1772, Mr. YOUNG, an ingenious surgeon at Shiffnal in Shropshire, and Mr. WALTIRE, who gives very accurate lectures in natural philosophy, made, at my request, the following experiments.

1. A part of the jugular vein of a sheep, with the blood in it, was included between two strict ligatures, during the animal's being alive, and being cut out with the ligatures, was immediately put into a glass of warm water, and placed in the receiver of an air-pump: it sunk to the bottom of the water, and would not rise when the air was diligently exhausted. It was then wiped dry, and laid on the brass floor of the receiver, and the air again exhausted, but there was not the least visible expansion of the vein, or its contents.

2. A ligature was put round the neck of the gall-bladder of the same animal, as soon as it was slaughtered; the gall-bladder, with the bile in it, was first put into water, in which it sunk, and was placed in the exhausted receiver of the air-pump; and was afterwards wiped dry, and laid on the brass plate at its bottom, as in the former experiment; but in neither case, on the greatest degree of exhaustion, did it shew the least alteration of its bulk.

3. The neck of the urinary bladder of the same animal was well secured with a ligature, and contained about two or three ounces of fluid. The bladder sunk immediately on being put into warm water; but, upon exhausting the receiver, many silver-like globules appeared upon the surface of it; and it soon shewed manifest signs of expansion, and rose to the top of the vessel. The same experiment was tried with it wiped dry, and laid on the floor of the receiver, and the result was, that its expansion and contraction were very perceptible to the eye.

In January 1773, by the assistance of Mr. WEBSTER, an ingenious surgeon from Montrose, the above experiments were repeated in the manner following.

A part of the *vena cava inferior* of a large swine, which was killed by some strokes on his head with an axe, was intercepted, when full of blood, between two ligatures. The part was about an inch and an half long, and held, by conjecture, near an ounce of blood; this was immersed in warm water, as soon as it was cut out of the warm body, and immediately put into the receiver of an air-pump. The air was well exhausted, and again let into the receiver repeatedly, without any appearance of enlargement of the vein; which must have been easily perceivable by its ascending in the warm water.

The same experiment was tried on the urinary bladder, with the same success, the *urethra* being tied with a ligature, whilst it was still in the body.

The gall bladder rose in the warm water, though the bile-duct was tied before it was taken out of the body, and had air bubbles appearing on its sides,
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like globules of quicksilver, as happened to the urinary bladder in the experiments at Shiffnal; which, in both cases, we ascribed to some portion of cellular membrane adhering to the bladders, into the cells of which, at the time of cutting them out, some air had insinuated itself.

In these experiments the water, in which the animal parts were immersed, was warmed to about an hundred degrees of Fahrenheit's scale, lest a greater degree of heat in the water might have raised an elastic vapour from these fluids, which did not naturally exist in the living animal, and all the parts were well cleared from the cellular membrane and fat; as it was imagined the atmospheric air might intrude itself into the cellular membrane, as is seen in tearing off the skins of animals recently killed, and which did indeed disappoint two of the above experiments, as was manifest from the silvery globules, which appeared upon the surfaces of the bladders.

From the facts established by these experiments, we may draw the following conclusions.

1. That so great a change is produced in the blood, by its receiving, in its passage from the arm of the patient to the basin, a great admixture of atmospheric air, that the experiments afterwards made on its sensible or chemical properties are rendered very uncertain and erroneous; since the fluid colour of the blood, its property of coagulation, and perhaps of putrefaction, may depend on this ascitic admixture of atmospheric air: and, at the same time, we see why so much less froth is produced in the operation of cupping, than from blood placed in the exhausted receiver of an air-pump; though

perhaps as great a degree of *vacuum* is made in one case as in the other.

2. It is probable, from these facts, that animal bodies can bear much greater variations of the pressure of the atmosphere, than the natural ones, without any degree of inconvenience. Some who have ascended high mountains are said to have been seized with a spitting of blood: but as this never happens to animals, that are put into the exhausted receiver of an air-pump, where the diminution of pressure is many times greater than on the summit of the highest mountains, it is probable it was an accidental disease, or was owing to some violent exertions in ascending. And in the curious account Dr. HALLEY gives of his descending in a diving bell so low, as to have the weight of many atmospheres over him, no other complaint is recorded, but a disagreeable sensation, as he was descending, like something bursting in his ears, and which recurred at about the same depth of water in his ascent.

From the above observations of Dr. HALLEY on the sensation in his ears, when he descended and ascended in the diving-bell, I was led to imagine, that the air contained behind the *tympanum* in the *vestibulum*, *cochlea*, and semicircular canals of the ear, had found or made itself a way into the *Eustachian* tubes, or into the external ear, by some undiscovered passage; and concluded, that a similar operation might be of service to some deaf people, where the immediate cause of their deafness might be owing to the excess or defect of this internal air. For this purpose, a cupping-glass, which had a syringe to exhaust it, was put over the ears of three different

different people, who were very hard of hearing. The inequality of the mammoid process of the temporal bone, made it necessary to put two or three circles of wash-leather dipt in oil around the *belix* of the ear. On working the air-syringe, the external ear swelled, and became red; and at length the patients complained of pain in the internal ear, and the air was re-admitted. One of these three patients heard considerably better immediately after the operation, and received permanent advantage; the others received neither benefit nor disservice.

If this small degree of success from the use of the cupping-glass, as so little pain or trouble attends the operation, should encourage other deaf persons to make use of it, it may be a means to give some light into the intricate diseases of this organ, the structure of the parts of which, and their uses are yet so little understood.